

SURGICAL MASK CONTACT DERMATITIS AND EPIDEMIOLOGY OF CONTACT DERMATITIS IN HEALTHCARE WORKERS

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ABSTRACT

Although contact dermatitis in healthcare workers is common, there are very few case reports about surgical mask dermatitis. Contact dermatitis due to N95 masks during the severe acute respiratory syndrome (SARS) pandemic has been documented in a few studies. It has been attributed to free formaldehyde which was confirmed to be present in certain types of N95 mask. None of the cases studied was found to be related to dibromodicyanobutane, which is found predominantly as a preservative in detergents used in the healthcare environment. In this article a case is presented to illustrate important aspects of contact dermatitis in healthcare workers, particularly surgical face-mask contact dermatitis. The article further explores dibromodicyanobutane as a known cause of allergic contact dermatitis (ACD).

BACKGROUND

Although some reports suggest a decrease in the incidence of occupational skin diseases in Europe,^{1–3} they are still one of the most prevalent occupational diseases in developed countries.^{4,5} Occupational skin diseases represented 28.6% of all the reported occupational diseases in Germany in 2002.⁶ The annual estimated incidence rate for occupational skin-disease cases reported to compensation authorities in Europe is 0.5–1.9 per 1 000 full-time workers.⁴ However, under-reporting and under-diagnosis of occupational diseases could have resulted in incomplete national registries of these diseases and, therefore, the true incidence rate of occupational skin disease could be higher.⁷ The most common reported occupational skin diseases are occupational contact dermatitis (OCD), occupational contact urticaria, occupational acne, and infections. Of all the occupational skin diseases reported in Europe and the United States, OCD accounts for 70–95% of the cases.^{8–13} Occupational skin diseases in general affect blue-collar workers as well as white-collar workers but the disease's spectrum in each job category differs according to the type and duration of exposure and prevention measures employed. Healthcare workers account for one of the main workplace categories affected by occupational skin diseases.^{14–17}

CASE REPORT

A 32-year-old male, working as a scrub nurse in theatre, presented with a six-month history of an intermittent erythematous scaly itching rash on the face. He later also

developed intermittent itchy erythematous swelling of the eyelids. He attributed his rash to contact with the new fog-free surgical face mask (see Figure 1) that he used in theatre, because the rash started after its introduction at the hospital. He noticed that the rash resolved during holidays and time off from work. The man had been treated with Advantan® cream and emollient with mild improvement but he continued to experience exacerbations after resuming his duties. He had no personal history of atopy, but there was a family history of allergic rhinitis. His medical and dermatological history was unremarkable; in particular, he had no past history of acne.

On examination, he had prominent erythematous swelling of the eyelids. On the face he had an erythematous papular rash, open comedones, lichenification and inflammatory pustules which were prominent on the cheeks along the mask contact line (see Figure 2). The nose, forehead and the post-auricle areas were spared. The rest of his skin was uninvolved. Based on his history and the examination, the differential diagnoses considered were occupational acne vulgaris, OCD or a combination of the two conditions. A patch test with 45 commercially available common allergens was performed according to the Contact Dermatitis International Research Group Guidelines.¹⁸ After 72 hours, a 1+ reaction to carba mix (rubber allergen) and a 2+ reaction to 0.3% dibromodicyanobutane (preservative) were noted. A specific patch test was performed with potential causative substances identified from the workplace; these included pieces of all the surgical masks and nitrile gloves worn



Figure 1: The newly introduced fog-free surgical mask identified by the patient as causing his facial rash. The foam strip is on the upper edge of the mask under the strip of blue textile.



Figure 3: The 2+ reaction evident on removing the patch-test chamber containing a piece of the mask polyester foam strip after 48 hours of occlusive contact with the skin.

plus dilutions of the detergent used for hand hygiene. The patient developed severe itching 36 hours after applying the work allergens. This was particularly localised to a single chamber containing a piece of the foam strip from the culprit mask (see Figure 1). The chambers were to be left in situ for 96 hours as they contained textiles, but the affected chamber was removed at 48 hours and a 2+ reaction was documented (see Figure 3). The other chambers were removed after 96 hours, but apart from the foam strip 2+ reaction, no other reactions were observed.

The manufacturer of the mask denied the use of any of the agents. But we found positive on commercial allergen patch testing, dibromodicyanobutane preservative in the adhesive used to attach the polyester foam strip to the mask textile was considered the most likely cause of the patient's contact dermatitis. Independent chemical analysis of the mask components is awaited. The provisional diagnosis



Figure 2: The patient's rash on presentation with prominent erythematous swelling of the eyelids and erythematous papules, open comedones, lichenification and inflammatory pustules prominent in areas of contact with the face mask.

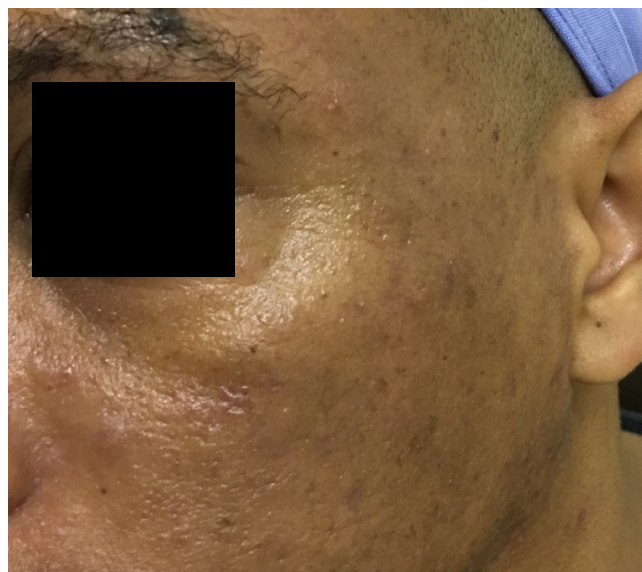


Figure 4: The patient's face showed significant improvement at follow-up after six months of avoiding mask usage and using an emollient, despite his having been off topical corticosteroid for five months. Post-inflammatory pigmentary changes and some open comedones were all that remained.

was OCD due to dibromodicyanobutane released from the mask, and mild occlusive acne. He was instructed to avoid the implicated mask and to use only masks that had tested negative in the specific patch of work-identified substances. He was treated with a potent topical steroid for one month only and emollient as needed. He was reviewed after six months and his rash had improved significantly (despite having been off topical corticosteroid for five months), leaving post-inflammatory pigmentary changes and some open comedones (see Figure 4).

EPIDEMIOLOGY OF OCCUPATIONAL SKIN DISEASES AND OCD IN HEALTHCARE WORKERS

The term 'healthcare workers' refers to diverse workplace categories that include nurses, physicians, laboratory technicians, cleaners, dietician and food handlers.¹⁹ The estimated prevalence range of occupational skin diseases in healthcare workers is 16.5–55%.^{14–17,20} Prevalence is dependent on country and reporting system used. Occupational irritant contact dermatitis (ICD) and occupational ACD constitute the most reported cases. In healthcare workers with occupational skin diseases, the prevalence of occupational ICD range is 45.1–52.6%, and the prevalence of occupational ACD is 19.7–27.4%,^{17,20,21} dependent on country and reporting system used. In 5–25% of healthcare workers ACD and ICD coexist.^{22–25} Contact dermatitis in healthcare workers affects the hands predominantly (60%), the face (13%), with a scattered or generalised distribution in 10%.²² The high prevalence of OCD in healthcare workers is due to the fact that they are exposed to a variety of different agents (see Table I) which are known to harm the skin barrier and/or cause sensitisation in susceptible individuals exposed to them.

EXPOSURES ASSOCIATED WITH OCCUPATIONAL ICD IN HEALTHCARE WORKERS

As indicated above, the most prevalent form of contact dermatitis among healthcare workers is hand dermatitis.^{26–29} This is attributed to exposure to irritants in their work environments (see Table I), particularly excessive hand washing and the use of personal protective wear such as gloves.^{29,30} Repeated exposure to water and other irritants causes cumulative disruption of the skin barrier and ultimately the visible skin changes of ICD. The use of detergents has been shown to disrupt the skin-barrier function by removing intercellular lipids, leading to ICD.^{31–33} Using gloves for extended periods of time leads to sweating that exacerbates or causes ICD,^{31,34,35} and donning and removing gloves leads to shearing of the skin.²⁰ Disruption of the barrier increases exposure to allergens, predisposing to sensitisation and ACD in susceptible individuals.²⁹

TABLE I: COMMON CAUSES OF OCCUPATIONAL ICD IN HEALTHCARE WORKERS¹⁹

Water
Soaps
Antiseptics/germicidals
Alcohol (ethyl, isopropyl)
Drying agents (aluminum acetate)
Miscellaneous medications
Ethylene oxide
Hygroscopic agents (plaster of Paris)

EXPOSURES ASSOCIATED WITH OCCUPATIONAL ACD IN HEALTHCARE WORKERS

Occupational ACD is less common than ICD in healthcare workers.^{17,20,21} It can be treated if the allergen triggering

the disease has been identified and the patient is able to avoid further exposure to it.¹⁹ The common identified allergens have changed over the past century and are still changing because of alterations in composition of the materials and agents being used in the manufacture of medical and pharmaceutical products and the introduction of alternative drugs and processes. During the the past century, penicillin and sulfonamide antibiotics with mercurial antiseptics were the leading causes of ACD in healthcare workers.¹⁹ Currently, the commonly implicated medications causing allergic reactions include tetrazepam and other benzodiazepines, bacitracin, neomycin sulphate, tixocortol-21-pivalate and benzoyl peroxide.^{36–39}

The most common relevant general offending allergens also affecting healthcare workers are thiuram and carbamates (rubber accelerators and additives), thiomersal (vaccine preservative), benzalkonium chloride (preservative), formaldehyde, glutaraldehyde (disinfectants), quaternium 15 (formaldehyde-releasing [HYPERLINK "http://www.dermnetnz.org/topics/contact-allergy-to-preserved/"](http://www.dermnetnz.org/topics/contact-allergy-to-preserved/) preservative) and fragrances used in pharmaceutical products.^{20,22–24} Formaldehyde and formaldehyde-releasing preservatives are used widely in many products in our environment, both generally and in healthcare. This makes it difficult sometimes to establish whether proven allergies are work-related. Disposable gowns and masks, used as personal protective equipment, have been described as potential formaldehyde exposures in healthcare settings.

MASK CONTACT DERMATITIS

The epidemiology of occupational skin diseases due to masks used in the healthcare settings is not well documented and epidemiological studies addressing this topic are rare. Most publications are case reports among healthcare workers during the SARS pandemic between 2002 and 2004, and most of them report adverse skin reactions to N95 masks. A study by Foo et al⁴⁰ in Singapore showed that 35.5% of healthcare practitioners in their cohort who used N95 masks regularly during the SARS pandemic developed adverse skin reactions. Of these patients, 59.6% developed acne, 51.4% developed facial itch and 35.8% developed a facial rash. Two healthcare assistants in Singapore, who had worn N95 facial masks for a continuous period of approximately three months during the SARS pandemic, developed exacerbations of acne of the skin occluded by the mask.⁴¹ They improved after acne treatment with systemic antimicrobials and topical retinoid. Donovan et al,⁴² in a study of healthcare workers who used N95 face masks during the SARS pandemic in Toronto, reported three patients diagnosed clinically with contact urticaria and two patients with ACD. Patch testing done in eight out of the 13 patients evaluated at the clinic showed that two patients tested positive for ethylene urea melamine formaldehyde and quaternium-15. One of these two patients also tested positive for formaldehyde. The analysis of the N95 mask used by the latter patient

TABLE II: ALTERNATIVE NAMES USED FOR DIBROMODICYANOBUTANE⁵⁶

Methyldibromo glutaronitrile (MDBGN)
1-Bromo-1-(bromomethyl)-1,3-propanedicarbonitrile
2-Bromo-2-(bromomethyl) glutaronitrile
2-Bromo-2-(bromomethyl)pentanedinitrile
1,2-dibromo-2,4-dicyanobutane
Bromothalonil
2-phenoxyethanol
Euxyl K400
Tektamer 38
Merquat 2200
Metacide 38

confirmed the presence of free formaldehyde in his mask. This was unexpected, since it was not displayed on the manufacturer's list of ingredients.⁴³ In contrast, healthcare workers who used paper or surgical masks during the SARS pandemic did not report any adverse skin reactions.⁴⁰

ACD due to surgical masks is rarely reported. Kosann et al⁴⁴ reported a case of occupational ACD in a senior resident in an obstetrics and gynaecology department. She presented with pruritic eruptions of the forehead, eyelids and cheeks which would develop 12–24 hours after being in an operating theatre and which improved during vacations. She tested positive for thiuram. ACD to thiuram – thought to be present in the elastic ear strap of the mask – was diagnosed. A diagnosis of ACD due to the elastic ear strap of the mask used by an orthodontic assistant was also reported by Hamann et al.⁴⁵ She suffered from facial and hand dermatitis, which resolved completely during holidays and time off from work. She was found positive to multiple dental allergens on patch testing. Thiuram found in the elastic straps of the masks accounted for her facial eczema. Komericki et al⁴⁶ reported a case of ACD in a patient in whom a non-disposable face mask was used during general anaesthesia induction. She presented with eczematous lesions on her face corresponding to areas that were in contact with the mask. Patch testing

showed that the probable cause was a preservative, cocospylenediamin-guanidinium-diacetate, used to disinfect medical instruments and apparatus.

DIBROMODICYANOBUTANE

Dibromodicyanobutane ($C_6H_6Br_2N$) is bromine that contains preservatives. It has been referred to in the literature by different names and structures, which are outlined in Table II.

It has been widely used in a variety of industries since the 1980s, ranging from cosmetic manufacture to heavy industry, as is summarised in Table III. It was originally used in leave-on and rinse-off cosmetic products in concentrations up to 0.1% (1 000 ppm). This exceeded the threshold for allergic reactions in some patients sensitised to dibromodicyanobutane by 20 times.⁴⁷ Concentrations as low as 0.001% (10 ppm) have the potential to cause sensitisations in some patients.⁴⁸ Rinse-off products with low concentrations of dibromodicyanobutane can cause sensitisation if used multiple times a day, resulting in cumulative exposure in excess of the recommended exposure allowance.^{49,50} The rate of dibromodicyanobutane sensitisation increased in Europe from 0.7% in 1991 to 3.5% in 2000⁵¹ and continued to increase to 4.5% in 2009.⁵² These reactions were found relevant in up to 75% of patients.⁵³ The European Commission consequently banned its use, first, in leave-on products in 2003⁵⁴ and, subsequently, in rinse-off products two years later.⁵⁵

The first case of ACD due to dibromodicyanobutane was reported in 1983 in a mechanic who used glue preserved with Tektamer 38 to attach labels.⁵⁶ Subsequently, it was considered as one of the top three preservatives that cause ACD in North America^{57–59} and accounted for about 6.3% of hand-allergic dermatitis cases in North America.⁵⁹ Of these, 11.8% were attributed to occupational exposures, most commonly to solvents, oils, lubricants and cosmetics.⁵⁹ A study in Denmark found that 14% of ACD cases due to dibromodicyanobutane were work-related.⁶⁰ Most of the cases were healthcare workers and were attributed to exposures to liquid soap. None of them was attributed to

TABLE III: PRODUCTS THAT MAY CONTAIN DIBROMODICYANOBUTANE^{53,56,62,63}

Cosmetic and self-hygiene products	Commercial/industrial products
Body creams	Latex emulsions
Massage oils	Water-based paints
Make-up	Glues and adhesives
Dishwashing liquids	Medical products such as ultrasound gels.
Facial/hand lotions	Paper and paperboards
Baby lotions	Fabric softeners
Baby wipes and moist toilets papers	Cutting and drilling oils
Liquid detergents and shower gel	Seed disinfectants
Sunscreens	Wood preservatives
Cleansers and other skincare products	Colour photographic processing solutions
Fabric softeners	Joint cements

exposure to surgical masks.

There have been no published reports of dibromodicyanobutane allergy related to face masks. A case report of dibromodicyanobutane ACD due to the adhesive used in a sanitary pad has been published.⁶¹ The patient described in our case study could have been exposed to dibromodicyanobutane used during the manufacture of the foam strip or through the adhesive used to attach the polyester foam strip to the mask textile.

CONCLUSION

Contact dermatitis due to surgical masks is rarely described in the published literature and related dibromodicyanobutane allergy has not been described before. In this case study, a 32-year-old male theatre scrub nurse presented with OCD on his face on a background of mild acne. Based on clinical history, examinations and patch testing, the most

likely cause was dibromodicyanobutane released from the recently introduced surgical face mask used. After avoiding using the mask, the clinical presentation of the patient improved significantly.

DECLARATION OF CONFLICT OF INTEREST

The author declares no conflict of interest.

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